

IN THE CLAIMS

1 32. (previously presented) A method for estimating a property of a fluid, comprising:
2 (a) transmitting a first acoustic pulse in a first member that is in contact with the
3 fluid;
4 (b) detecting a plurality of acoustic pulse echo returns from an interface between
5 the first member and the fluid; and
6 (c) estimating the property of the fluid from the plurality of acoustic pulse echo
7 returns.

1 33. (currently amended) The method of claim 32 +, wherein the property of the fluid
2 comprises one at least one of the set consisting of acoustic impedance, density and
3 viscosity of the fluid.

1 34. (currently amended) The method of claim 32 +, further comprising:
2 estimating a reflection coefficient of the interface between the first member and
3 the fluid.

1 35. (currently amended) The method of claim 32 +, further comprising:
2 estimating an acoustic impedance of the first member.

1 36. (currently amended) The method of claim 32 +, further comprising:
2 estimating a slope of energy decay for the plurality of acoustic pulse echo
3 returns.

1 37. (currently amended) The method of claim 36 5, wherein estimating the slope of
2 energy decay comprises performing a least squares fit to the plurality of acoustic
3 pulse echo returns.

1 38. (currently amended) The method of claim 36 5, wherein estimating the slope of
2 energy decay comprises dividing each of the plurality of acoustic pulse echo
3 returns into a plurality of time windows.

1 39. (currently amended) The method of claim 38 7, wherein estimating the slope of
2 energy decay further comprises integrating over each of the plurality of time
3 windows.

1 40. (currently amended) The method of claim 36 5, wherein estimating the slope of
2 energy decay further comprises subtracting noise from each of the plurality of
3 acoustic pulse echo returns.

1 41. (currently amended) The method of claim 32 4, further comprising:
2 transmitting a second acoustic pulse through the fluid; and
3 estimating speed of sound through the fluid, using round trip travel time for the
4 second acoustic pulse between the first member and a second member that is in
5 contact with the fluid.

1 42. (currently amended) The method of claim 32 4, further comprising:

2 transmitting a second acoustic pulse through the fluid; and
3 estimating attenuation of the second acoustic pulse through the fluid.

1 43. (currently amended) The method of claim 42-44, wherein estimating the attenuation
2 includes estimating the attenuation at a plurality of frequencies.

1 44. (currently amended) The method of claim 41-40, wherein transmitting the second
2 acoustic pulse further comprises transmitting a plurality of acoustic pulses at a
3 plurality of frequencies.

1 45. (currently amended) The method of claim 32-4, wherein the method is performed
2 downhole.

1 46. (previously presented) An apparatus for estimating a property of a fluid, comprising:
2 a vessel that contains the fluid;
3 an acoustic pulser that transmits a first acoustic pulse into a first vessel member
4 that is in contact with the fluid;
5 a transducer that detects a plurality of acoustic pulse echo returns from an
6 interface between the first vessel member and the fluid; and
7 a processor that estimates the property of the fluid from the plurality of acoustic
8 pulse echo returns.

1 47. (currently amended) The apparatus of claim 46~~15~~, wherein the vessel comprises one
2 of at least one of the set consisting of a flask, pipe, conduit, sample chamber,
3 flow pipe, tube, channel, and downhole tool housing.

1 48. (currently amended) The apparatus of claim 46~~15~~, wherein the property comprises
2 one of at least one of the set consisting of acoustic impedance, density and
3 viscosity of the fluid.

1 49. (currently amended) The apparatus of claim 48~~17~~, wherein the processor estimates
2 a reflection coefficient of the interface between the first vessel member and the
3 fluid.

1 50. (currently amended) The apparatus of claim 49~~18~~, wherein the processor measures
2 acoustic impedance of the first vessel member.

1 51. (currently amended) The apparatus of claim 45~~15~~, wherein the processor estimates
2 a slope of energy decay for the plurality of acoustic pulse echo returns.

1 52. (currently amended) The apparatus of claim 51~~20~~, wherein the processor performs a
2 least squares fit to the plurality of acoustic pulse echo returns.

1 53. (currently amended) The apparatus of claim 51_20, wherein the processor divides
2 each of the plurality of acoustic pulse echo returns into a plurality of time
3 windows to reduce noise.

1 54. (currently amended) The apparatus of claim 53_22, wherein the processor integrates
2 over each of the plurality of time windows.

1 55. (currently amended) The apparatus of claim 51_20, wherein the processor estimates
2 the slope of energy decay from a value adjusted for noise for each of the plurality
3 of acoustic pulse echo returns.

1 56. (currently amended) The apparatus of claim 46_15, wherein the acoustic pulser
2 transmits a second acoustic pulse through the fluid and the processor estimates the
3 speed of sound through the fluid using the round trip travel time for the second
4 acoustic pulse between the first vessel member and a second member that is in
5 contact with the fluid.

1 57. (currently amended) The apparatus of claim 46_15, wherein the acoustic pulser
2 transmits a second acoustic pulse through the fluid and the processor estimates
3 attenuation of the second acoustic pulse through the fluid.

1 58. (currently amended) The apparatus of claim 57_26, wherein the processor estimates
2 the attenuation at a plurality of frequencies.

1 59. (currently amended) The apparatus of claim 56 25, wherein the acoustic pulser
2 transmits a plurality of pulses at a plurality of frequencies.

1 60. (currently amended) The apparatus of claim 46 15, wherein the apparatus is located
2 downhole.

1 61. (previously presented) A method for estimating a property of a fluid, comprising:
2 (a) generating a first acoustic pulse in the fluid that is in contact with a first
3 member;
4 (b) detecting a plurality of acoustic pulse echo returns from an interface between
5 the first member and the fluid; and
6 (c) estimating the property of the fluid from the plurality of acoustic pulse echo
7 returns.

1 62. (previously presented) An apparatus for estimating a property of a fluid, comprising:
2 a chamber that contains the fluid;
3 a transmitter that sends a first acoustic pulse into the fluid that is in contact with a
4 first chamber member;
5 a transducer that detects a plurality of acoustic pulse echo returns from an
6 interface between the first chamber member and the fluid; and
7 a processor that estimates the property of the fluid using the plurality of acoustic
8 pulse echo returns.

- 1 63. (previously presented) A downhole tool which is deployed in a borehole for
 - 2 estimating a property of a downhole fluid, comprising:
 - 3 a vessel that contains the fluid;
 - 4 an acoustic pulser that transmits a first acoustic pulse into a first vessel member
 - 5 that is in contact with the fluid;
 - 6 a transducer that detects a plurality of acoustic pulse echo returns from an
 - 7 interface between the first vessel member and the fluid; and
 - 8 a processor that estimates the property of the fluid using the plurality of acoustic
 - 9 pulse echo returns.
-
- 1 64. (currently amended) The downhole tool of claim 63 32, wherein the vessel
 - 2 comprises one of a flask, pipe, conduit, sample chamber, flow pipe, tube, channel
 - 3 and downhole tool housing.
-
- 1 65. (currently amended) The downhole tool of claim 64 33, wherein the property
 - 2 comprises one of acoustic impedance, density and viscosity of the fluid.
-
- 1 66. (currently amended) The downhole tool of claim 65 34, wherein the processor
 - 2 estimates a reflection coefficient of the interface between the first vessel member
 - 3 and the fluid.
-
- 1 67. (currently amended) The downhole tool of claim 63 32, wherein the processor
 - 2 estimates a slope of energy decay for the plurality of acoustic pulse echo returns.

1 68. (currently amended) The downhole tool of claim 67 36, wherein the processor
2 performs a least squares fit to the plurality of acoustic pulse echo returns.

1 69. (previously presented) A method for estimating a property of a fluid, comprising:
2 (a) generating a first acoustic pulse in a first member that is in contact with the fluid;
3 (b) detecting a plurality of acoustic pulse echo returns from an interface between the
4 first member and the fluid; and
5 (c) estimating the property of the fluid from the plurality of acoustic pulse echo
6 returns.